THE DETONATION OF GUN COTTON.

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In the use of gun cotton in mines or torpedoes, advantage is taken of the discovery of Mr. E. O. Brown that gun cotton, which is completely saturated with water, may be detonated by the detonation of "dry" gun cotton in direct contact with it, for it thus becomes possible to secure a large margin of safety for the naval vessels carrying gun cotton torpedoes by keeping the major portion of this cargo completly saturated with water so that it is immune from the danger common to the powerful nitric esters of accidental explosion through so-called "spontaneous combustion" while it is still available for use at any moment as a detonating charge. It is, in fact, as my experimental demonstrations have shown, an even more efficient rupturing or shattering explosive than the same volume of dry gun cotton is, the explanation of this increased efficiency being found in the increased density, and therefore rigidity, imparted to the porous mass through its interstices becoming filled with water.

The blocks, or discs, as thus used, contained, on the average, 35 per cent. of water. In practice, this wet charge, in the service torpedo, was fired or detonated by four 2-inch discs of "dry" gun cotton, or its equivalent in $\frac{1}{2}$-inch discs or blocks, which was known as the priming charge. As used the term "dry" meant air-dry and necessarily referred to a variable condition dependent upon the atmospheric conditions which obtained at any time and the exposure of the primer to these conditions.

It is desirable to know how reliable this system is and what assurance may be placed in it. This may to a degree be determined by ascertaining how much moisture the priming disks may contain and yet detonate the wet gun cotton with certainty. It was not feasible to carry this out on the large scale with charges of the mag-

nitude used in torpedoes, nor did it seem necessary to the solution of the problem that this should be done. As I have previously shown, such tests may be made upon single unconfined blocks or disks of wet gun cotton, resting upon rigid iron supports, the evidence of complete detonation being found in the impressions left upon the iron support with which the explosive is in contact, and this method was resorted to in this instance.

Number of Experiment.	Dry Primers, Grains.	Wet Primers, Grains.	Per Cent. of Moisture.	Results.
1	336	374	10.16	Detonated
2	293	330+	11.21	"
3	342	387	11.63	"
4	337	382	11.78	"
5	346	393+	11.96	"
6	330	376	12.23	Failed
7	294	337	12.77	Detonated
8	292	335	12.84	Failed
9	317	365	13.15	"
10	294	339	13.27	"
11	301	348	13.51	"
12	294	341	13.78	"
13	305	355	14.09	Detonated
14	292	340	14.12	Failed
15	286	336	14.88	"
16	289	340+	15.00	"
17	286	337	15.13	Detonated
18	289	343	15.74	Failed
19	287	341	15.84	"
20	295	351	15.95	"
21	279	333+	16.22	"
22	322	386+	16.58	"
23	293	353	17.00	"
24	313	378	17.20	"
25	301	364	17.31	"
26	320	390	17.95	"

In carrying out the tests steam-dried blocks of gun cotton, which were to be used as priming charges, were carefully weighed. They were then immersed in water for awhile and again weighed, the increase in weight showing the amount of water that had been absorbed by each priming block. Immediately after weighing, and before evaporation from the primer could take place, these primers were placed, one after the other, upon blocks of saturated "wet" gun cotton and fired by the service detonator, containing 35 grains of mercuric fulminate, in the usual manner. The results of the trials are set forth in the following table, in which they are arranged

in the ascending order of the percentage of water present in the priming blocks, although of necessity the experiments were made on the primers as taken from the water and containing varying quantities of this substance.

The results show that detonation was effected in every case in which the primer contained less than 12 per cent. of moisture, but that this also occurred in experiments number 7, 13 and 17, in which the primers contained 12.77, 14.09 and 15.13 per cent. of water respectively. These irregularities may be explained by the irregularity of absorption of water by these blocks, owing to a lack of regularity of porosity in them, for we can readily understand that if the centers of these blocks, about the detonator holes, were more highly compressed and therefore denser than a portion of the remainder of each block, while the total water absorbed by the block would be represented by the percentages given, yet the center might remain dry enough to respond to the effect of the detonation of the mercuric fulminate in the detonator, and thus determine the detonation of the whole primer and also of the wet gun cotton block with which the latter was in contact. This criticism may also apply in a reverse manner to the primers containing less than 12 per cent. of water, but the likelihood of such an excess of water about the detonator hole as to prevent the detonation of the primer becomes the more remote the less the total percentage of water present. It is true that these vagaries may have sometimes been due to variations in the detonators used, but this factor was eliminated in these experiments, so far as seemed possible, by previous severe tests of the detonators. Admitting all of these possibilities, it would still seem reasonable to conclude from these experiments that primers containing less than 12 per cent. of water, when fired by means of a detonator containing 35 grains of mercuric fulminate may be relied upon, so far as the moisture content is concerned, to detonate wet gun cotton with which they are in contact.

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